PALAEOBIOGEOGRAPHICAL PERSPECTIVES ON *PINUS PINEA* L: A CONTROVERSIAL AND ENIGMATIC MEDITERRANEAN PINE

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Inconsistencies in the opinions of plant biogeographers

The role of pines (and its naturality) in certain areas of the Mediterreanean has been a theme of intense debate among geobotanists. In this context, the authoctony of *Pinus pinea* has been traditionally considered the most controversial of all the species of the genus. Their edible nut is responsible of a long history of trade and presumably of introduction throughout Europe and N Africa, but great incertitude and inconsistencies are detected when analysing the opinion of "field" plant biogeographers (Table 1).

	Zangheri in Francini (1958)	Endlicher in Parlatore (1867)	Pavari 1955	Briquet in Francini (1958)	Rikli (1943)	Feinbrun (1959)	Germer (1985)	Mouterde, (1966), Browicz, (1994)	Ceballos and Ruiz de la Torre (1979)	Costa et al. (1997)	Bazile Robert (1981)
Iberian Peninsula					N	N			M?	N	
South of France										N	N
Balearic islands											
Corsica and Sardinia				N		N					
Italian Peninsula	M									N?	
Sicily			N								
Aegean coast										N?	
Crete		N							N		
Greece	N?				M?	N				?	
Turkey	N?				M?	N			N	N	
Lebanon	N?				M?	N				N	
Syria							N	M			

Table 1. Some divergent opinions compiled from key references treating the origin of the Stone pine in the botanic literature. N: natural; N?: natural with uncertainties; M: introduced by Man; M?: probably introduced ?: In dispute. References of this table are not extensively included in the reference list at the bottom of this poster, but they be obtained by emailing the authors

Why *Pinus pinea* L. is unique?

1) It is the only Mediterranean pine having a big, edible, kernel

2) It has a very depauperate genetic diversity across its range

3) The female gametophyte ripen earlier (spring) than in other pine species (after the summer)

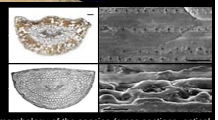
4) Cones and seeds need 3 years to ripen (whereas in almost all other pines this takes only two years or less)

5) It is the only having such a characteristic crown shape (that is why this pine is named Umbrella pine!)

6) Leaf morphology and stomatal features differs greatly from the other pine species: no vascular ducts in cross section of leaves and characteristic features

▲Fig 1. Distribution area of *Pinus pinea*

◄ Fig. 2. Typical crown shape of the "*Parasol*" (*Umbrella*) pine. Segovia.



▲ Fig. 3. Leaf morphology of the species (cross sections, optical microscopy, at right) and leaf ornaments (left, as seen with SEM)

Difficulties in the obtaining of Palaeoecological data to the species level

Its palaeoecological information is very limited due primarily because most of the fossil vegetation evidence is obtained by pollen and the taxonomic precision attained by pollen analysts is insufficient to detect this tree.

Macroremains are needed to unequivocally detect the species in the fossil record. This includes kernels or anatomically well preserved wood, but also leaves (see box at the right!)

Furthermore, records with macroremains are rarely found in mediterranean environments, especially in those sites that could be highly suitable for this species (i.e. rocky or sandy substrates) which could constitute a bias in the palaeobiogeographical contexts, (greater presence in archaeological sites).

LEAF MORPHOLOGY OF PINES IS IS ALSO USEFUL TO IDENTIFY FOSSILS!

* Following *Flora Europaea*, the existence of two or more resin ducts in the leaves is a main feature that distinguish the genus *Pinus*. However, in *Pinus pinea* they are frequently absent (García Álvarez, 2010, Sutherland, 1934)

* The pore size in *P. pinea* is noticeably smaller than in the other pines, allowing its numerical differentiation. Furthermore, the pore do not correspond, either in shape or in size, to the outline of the epistomatal chamber floor plan and it is present in a different focal plane. This indicates a unique form of stomatal complex for this species.

▲ **Fig. 4 Map showing sites (or areas) with presence of *Pinus pinea* throughout the Quaternary:** 1 NW Portugal (Bronze Age to Roman, Figueiral 1993); 2 Ponta da Passadeira (Neolithic, Carrión Marco 2005); 3 Vila Nova de S. Pedro, (Neolithic, Alfonso do Poço 1994); 4 Zambujal, (Eneolithic, Hopf 1981); 5 Vale Pincel, (Neolithic, Carrión Marco, 2005); 6 Pontes de Marchil, (Bronze Age, Pinto da Silva 1988); 7 Gorham's and Vanguard Caves, Gibraltar (Mid- to late Pleistocene and Holocene, Metcalf 1958, Finlayson 1999, Gale and Carruthers 2000); 8 La Falguera, (Mesolithic-Neolithic-Bronze, Carrión Marco 2002); 9 Cova de l'Or, (Neolithic, Vernet et al. 1987); 10 La Fonteta Ràquia (3rd century BC , Jardón et al. 2009); 11 Lloma del Betxí (Neolithic, Grau 1991); 12 Fuente Álamo (Bronze Age, Schoch and Schweingruber 1982) 13 Cueva de Nerja (Upper Paleolithic to Neolithic, Badal 1998); 14 El Cigarralejo (9th and 4th centuries BC, Cuadrado 1987, Rivera-Núñez and Obón 2005); 15 El Amarrejo (4th-2nd centuries BC, Broncano, 1989); 16 Cabezo del Ito Pío (4th century BC, Rivera-Núñez and Obón 1990); 17 Casa del Monte (4th century BC, Badal inéd.); 18 Castillo de Doña Blanca (Tartesian, protohistoric, Chamorro 1994, Ruiz et al. 1995); 19 Hoyo de la Mina (Neolithic, Uzquiano 2002); 20 Huelva and Punta Umbía (7th century BC to modern age, Sánchez Hernando, 2005); 21 Duero Basin (Iron Age, Uzquiano 1995, Rubiales et al 2011, Hernandez et al. in press); 22 Maures massif and Durance valley (Late Würm, Bazile- Robert 1981); 23 Pompeii, Napoli (Roman, Robinson 2002); 24 Veli Brijun, Croatia (Roman, Sostaric et al 2001); 25 Nijmegen, Netherlands(Roman, Bakels and Jacomet 2003); 26 Worb-Sunnhalde, Switzerland (3rd century AD, Brombacher 1998)

Palaeoenvironmental data is almost exclusively linked to archaeological sites

Pre-Quaternary data (including related taxa) is scarce and fractionary, it is located in the Western and Central Mediterranean so far (South of France, Spain and Italy, Saporta 1864,1865, Zodda 1903, Wulff, 1944, Menéndez Amor, 1951).

In several coastal areas of Iberia (Portugal, Gibraltar and the Mediterranean coast) there is wide evidence for the existence of this species during the Holocene. At the Roman period it is distributed, at least, throughout the western Mediterranean area, including parts of inland Spain (i.e. the Northern Plateau) and several other northern areas of Central Europe, which should correspond to the introductions of kernels as luxury food from southern territories.

Genetic data shows that this species is (surprisingly) genetically depauperated, despite having a considerable phenotipic plasticity and adaptability (Fig. 6). This is interpreted as the result of a loss of genetic diversity due to a presumably prolonged bottleneck that could be related with the climatic oscillations (or the lack of seed dispersers) during periods of the Quaternary.

However, alternative scenarios could also have occurred: The existence of a long-term, stable and small range (located probably in the W Mediterranean), and the effects of anthropogenic domestication could have provoked a recent genetic decline and a simultaneous (and rapid) range expansion throughout the Mediterranean

◄ Fig. 6. Only in the three populations from Lebanon and two from Central Spain, distinct haplotypes were detected, but only differing by a single mutation from the ubiquitous haplotype (Vendramin et al., 2007).

▼Fig. 7. The population of Cadalso de los Vidrios (Central Spain), growing on rocky outcrops and sandy environments.

Some key References

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Due to limited space limitation, not all the references cited are included in this text. However, if you are interested in any of them, please write us!

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